REDUCED FIELD-OF-VIEW DIFFUSION-WEIGHTED IMAGING IN PATIENTS WITH INVASIVE BREAST CANCER

L. Singer[1], L. J. Wilmes[1], E. U. Saritas[2,3], A. Shankaranarayanan[4], E. Proctor[1], D. Wisner[1], B. Chang[1], B. N. Joe[1], D. G. Nishimura[3], and N. M. Hylton[1]
[1]Radiology and Biomedical Imaging, UCSF, San Francisco, CA, United States, [2]Department of Bioengineering, UC Berkeley, Berkeley, CA, United States, [3]Department of Electrical Engineering, Stanford University, Stanford, CA, United States, [4]Applied Science Laboratory, GE Healthcare, Menlo Park, CA, United States

Introduction: Diffusion-weighted magnetic resonance imaging (DW-MRI) has shown promise in the prediction of response to neoadjuvant chemotherapy in patients with locally advanced breast cancer [1-2]; however, technical limitations may limit this potential. Current echo planar DW-MRI sequences used in the breast are limited in spatial resolution and prone to distortion. A reduced field-of-view (rFOV) DW-MRI sequence providing high in-plane spatial resolution and the potential for reduced distortion was developed for use in the spine [3] and later modified for imaging of the breast [4]. We hypothesized that the sequence's higher spatial resolution would improve characterization of breast tumor heterogeneity, improving the ability to monitor and predict breast tumor response to chemotherapy. The objectives of our study were three-fold: 1) to evaluate quantitative differences in the measured tumor apparent diffusion coefficient (ADC) with the use of a rFOV DW-MRI sequence, as compared to a standard FOV DW-MRI sequence, 2) to assess differences in radiologists' qualitative assessment of tumor depiction on diffusion-weighted images acquired with the two sequences, and 3) to assess the potential clinical impact of rFOV DW-MRI by comparing the ability of tumor ADCs derived from quantitative analysis of data acquired with the two sequences to correlate with response to taxane-based neoadjuvant chemotherapy.

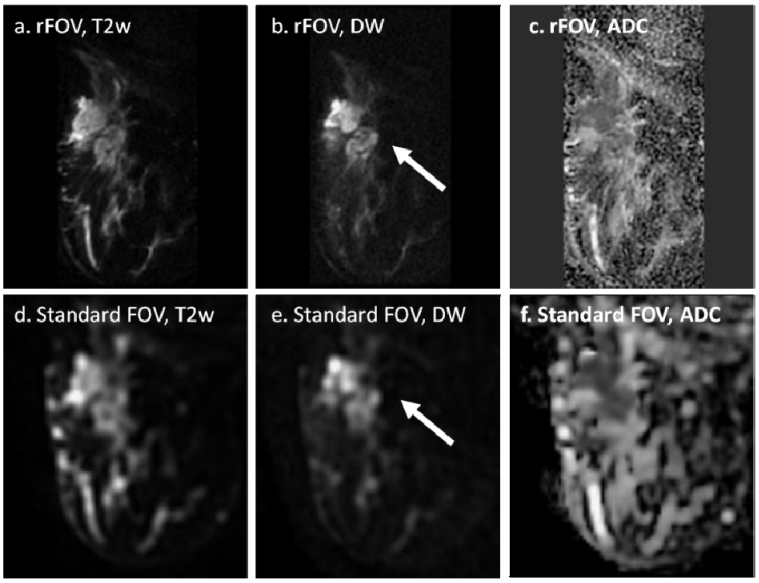

Fig 1. rFOV and standard FOV imaging data for a patient with invasive breast cancer. The tumor (arrow) appears more heterogeneous with rFOV DW-MRI. Both radiologists rated tumor depiction, heterogeneity, lesion conspicuity, and other qualitative features as superior on rFOV DW-MRI data as compared to standard. Quantitative analysis of the tumor ADC distribution showed that the minimum tumor ADC was lower with rFOV vs. standard FOV.

Methods: As part of ongoing IRB-approved studies at our institution, patients with locally advanced breast cancer and treated with neoadjuvant chemotherapy were scanned with MRI before and after initiation of treatment with neoadjuvant chemotherapy. All patients gave informed consent. A subset of patients was scanned with both rFOV and standard FOV DW-MRI at one or more MR exams. Differences in tumor ADCs measured with the two sequences were evaluated quantitatively by calculating tumor ADC distribution parameters including minimum and maximum tumor ADC, skew, kurtosis, mean, and median tumor ADC. The Wilcoxon signed-rank test was used to evaluate the statistical significance of differences between the two sequences (alpha=.05). To assess qualitative differences in tumor depiction, two radiologists visually assessed and qualitatively compared DW-MRI data acquired with the two sequences at the same exam. In a subset of patients, rFOV and standard FOV DW-MRI data were acquired both before (MR1) and after treatment with 1-3 cycles of taxane-based chemotherapy (MR2). MR3 was acquired after the completion of taxane-based chemotherapy. Based on dynamic-contrast enhanced MRI (DCE-MRI), a final decrease in MR tumor volume [4] of 65% or more ((MR3-MR1)/MR1) was considered a response to taxane-based chemotherapy and all other changes were considered a non-response. Early changes in tumor ADC distribution parameters ((MR2-MR1)/MR1) derived from the two DW-MRI sequences were correlated with the final volumetric response to taxane-based chemotherapy.

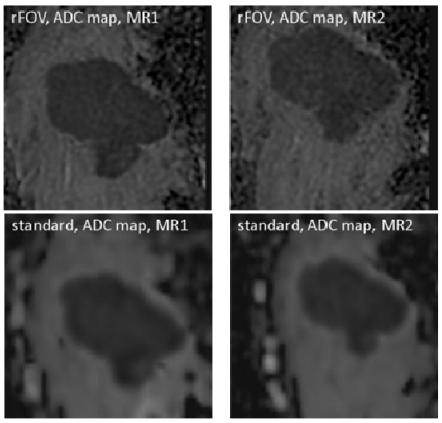

Fig 2. ADC maps from rFOV and standard FOV data acquired at MR1 and MR2. From MR1 to MR2, minimum tumor ADC decreased 29%, based on rFOV and increased 18%, based on standard FOV data. The change in tumor volume from MR1 to MR3 was classified as a non-response to taxane-based chemotherapy.

Results: The mean tumor ADC for both sequences was similar (p=0.519, N=12), but differences between the two sequences were found in other quantitative parameters related to the tumor ADC distribution, including the 12.5th percentile (p=0.02) and minimum tumor ADC (p=0.002). Qualitatively, visualization of tumor morphologic detail, tumor heterogeneity and lesion conspicuity was improved with rFOV DW-MRI (**Fig 1**). In a subset of 3 patients scanned with both DW-MRI sequences at MR1 and MR2, two patients were classified as having a non-response and one as having a response. In the responder, minimum tumor ADC increased from MR1 to MR2 in both rFOV and standard FOV acquisitions. In one nonresponder, minimum ADC decreased in the rFOV acquisition and increased in the standard FOV acquisition (**Fig 2**). In one nonresponder, rFOV minimum ADC increased and standard decreased.

Conclusions: Quantitative and qualitative differences in tumor depiction were found between the two sequences. Statistically significant differences between the sequences in lower ADC values are compatible with reduced partial voluming between tumor and normal fibroglandular tissue in rFOV DW-MRI, suggesting that rFOV DW-MRI may be valuable in imaging the lower ADCs expected to correspond to viable tumor in most invasive breast cancers. Qualitative differences suggest that rFOV may be useful in clinical interpretation of images, but diagnostic value should be assessed. In a small case series, early changes in rFOV minimum tumor ADC were consistent with volumetric response to taxane-based chemotherapy in two of three patients. Prognostic value should be assessed in a larger cohort. Prospective studies comparing the ability of rFOV and standard FOV parameters to predict clinical outcomes are needed.

References: 1. Pickles MD, MRI 24:843-847, 2006. 2. Sharma, U., NMR Biomed 22(1):104-13, 2009. 3. Saritas EU, ISMRM p.166, 2009. 4. Partridge SC, AJR 179:1193-9, 2002. **Funding**: NIH R01-CA69587, NIH R01-CA116182, CBCRP Dissertation Award